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PURPOSE AS TENDENCY AND ADAPTATION.

IN an earlier paper,¹ I have indicated my intention of studying interest or purpose as an objective phenomenon. Having rejected certain negative meanings of the conception, I submitted a provisional definition in agreement with verbal usage, according to which purpose consists in the *determination of an action by its agreement with the agent's expectation*. This definition enabled us to explain the familiar confusion known as the 'pathetic fallacy.' The earlier paper was then further devoted to an examination of the view which identifies purpose with *systematic unity*. I pointed out that this view fails to provide for the differentia of purpose provisionally adopted, according to which existence must not only exhibit unity, but must be 'for the sake of' that unity. In the present paper I wish to examine the view which identifies purpose with determination by the future, or with the forward reference of tendency and adaptation.

1. Such a view may be derived from the time relations of an ordinary causal system, when the logical conception of causality is substituted for the older and more naïve conception of causality as impact, or for the conception which Professor Holt has recently called "the bead theory."² According to this latter view causation proceeds from the past toward the future, a cause being an antecedent that exerts force upon something that follows passively after. That which comes later is because of what has come earlier; but that which comes earlier is in no sense because of what is yet to come. Causality in this sense is contrasted in the popular mind with purpose, which is supposed to have a forward reference in time. But the more recent conception of causality appears to destroy this antithesis. Causality is now thought of as exerted not by the particular antecedents of an event, but by the law. Through the law the determination of

¹ *The Monist.*, Vol. XXVII, July, 1917.

² *The Freudian Wish*, Supplement, p. 157.

each event may be said to have a forward reference, in that the law prescribes the future equally with the present. A body which is obeying the law of uniform acceleration is a body that is *going* to move at a prescribed velocity after a certain lapse of time. The determination does not proceed from the present to the past, but proceeds to both the present and the future from a law that is outside time. The temporal direction appears to be indifferent, or to be capable of being read either forward or backward. In terms of the law it is possible either to predict the future from the present; or to infer the past from the present, that is, from what is future *to the past*. Hence it may be said, the difference between mechanism and purpose turns out to be nothing more than the difference of sense in the causal relation; the two are complementary aspects of a temporal system determined by law.

Now if by causal determination we mean the relation between the law of the system and any phase of the system, as in the case of the relation between the law $v = gt$, and a particular velocity of the body at any given time, then we have over again that general conception of systematic unity which we have already considered. If there is anything new in the present notion it must lie in the relation among the particular phases themselves. Is it true that in a mechanical system of the ordinary type the temporal relations are symmetrical? I think not. The velocity of an accelerated body is primarily a function of its past history, and only secondarily a function of its future history. In order that a particular physical configuration may be regarded as a phase of the system $v = gt$, its time must be measured forward from the moment of origin. t in the formula means time that *has* transpired. When the past is inferred from the present, it is only after the present has already been defined in terms of the past. We virtually say: assuming that the body has moved for a certain time, and has now a certain velocity, its earlier velocities must *have been* such and such. In other words, in order to be able to infer the earlier from the later phases, it is necessary to assume that the later were determined by the earlier. The inference is *ex post facto*, and the fact from which the inference proceeds is the dependence of the body's velocity on the antecedent time of

its motion. Any particular velocity of the body is completely determined at the moment of its occurrence in terms of the past which that moment terminates; whether the body continues to move thereafter or not is indifferent. At the first moment its velocity is zero, however long may be the subsequent period of its motion; at the last moment its velocity is a positive quantity, even though the subsequent period of its motion be zero. Or, in the order of existence, time, measured from earlier to later, is the independent variable; even though in the order of inference the independent variable may be time measured in the converse direction. Unless this distinction were to be made between the order of determination in the series of existence, and the order of logical determination in *ex post facto* reasoning, it would be impossible to distinguish the case of inferring the past history of a positively accelerated body from the case of predicting the motion of a negatively accelerated body.

2. I have analyzed this notion of the temporal convertibility of ordinary mechanical determination, because although it has never in this elementary form itself been employed for the definition of purpose, it has been so used in a complex form. It is then spoken of as *trend* or *tendency*. It is my contention that there is no more justification for this use in the one case than in the other.

A determined temporal process is spoken of as a tendency whenever there is anything remarkable that distinguishes the later from the earlier phases. This may occur in one of two ways: either through the appearance of novelty or discontinuity within the process itself; or through the conjunction between the given process and some process that is external to it.¹

Let us first consider the type of 'tendency' in which only a single system is concerned. A moving body obeying the law of negative acceleration is said to tend to a condition of rest. Rest is not a small quantity of motion, but non-motion. A moving

¹ I deem it advisable to ignore that notion of tendency in which it is regarded as a loose or relatively undetermined process. Thus bodies were said to tend to the surface of the earth before the law of gravitation was understood; and one is said to have a tendency to this or that disease, when exact pathological conditions are unknown. It is not profitable to analyze any notion which is only a confession of ignorance.

body which comes to rest takes on a novel character that is qualitatively discontinuous with its earlier history. The state of rest is thus singled out from among the phases of the moving body as peculiar and remarkable. But there is no reason to say the state of rest is differently determined. The earlier behavior of the body can no more be said to occur for the sake of the moment of rest, than for the sake of any one of the other later moments when the quantity of its motion only approximates zero. So far as the determination of the process is concerned, the moment of rest is not unique, but is on the same plane with the rest. Or take the case of the second law of thermodynamics. The total energy of the cosmos is said to tend to resolve itself into heat and to become so distributed as to be incapable of doing work. This phase is qualitatively peculiar in respect of its homogeneity; and it is humanly interesting in that it would make life impossible. But it plays no unique rôle in the determination of the process. There is no sense in which it could be regarded as the purpose of the cosmos, that would not hold equally of any intermediate phases. Similarly, we speak of two bodies as tending to a common centre of gravity, or cooling water as tending to form ice. The state of equilibrium in a gravitational system, and the freezing point in a thermal system are crucial phases, in which novelty appears, and which are humanly remarkable, but they cannot be said in any sense to dominate the systems within which they fall, or to have any peculiar potency. They obey the law of the system, and are equally and reciprocally correlated with other phases of the system.

Now let us consider the type of tendency in which two or more systems are at least provisionally assumed. Suppose, first, that we consider the case of a moving body governed by the law of inertia, and coming into the neighborhood of a second moving body similarly determined. There results, let us suppose, a state of equilibrium in which they revolve about a common center of gravity. This new state differs notably from the earlier states of the two bodies in that it is unified, and in that the motions are circular instead of rectilinear. In this case we find that we were mistaken in supposing that we had to do with two independent

systems which accidentally intersected. We therefore correct our initial assumption and conceive the whole change as successive phases of one system governed by the law of gravitation. The two bodies do not form a system, strictly speaking, but *have been* a system all along by virtue of their mutual attractions. The stable periodicity of their motions is then only a phase of this system; a crucial phase, but not on that account, as we have seen, in any peculiar sense accountable for the changes leading up to it.

But in some cases independent systems collide, and give rise to resultant states that are not deducible from either system. This, as Professor Palmer has so well pointed out, is the meaning of chance in the positive or 'objective' sense.

"Chance might be defined as planless concurrence; and when it is so defined, we discover it all around us, in great things and in small. It was an accident that the winter was exceptionally severe after the landing on our shore of the Pilgrim Fathers; that the tower of Siloam fell on those particular persons; that the partridge flew past me when I did not have my gun. The liberties of England are largely due to chance in the storm which arose soon after the sailing of the Spanish Armada. For however minutely we might become acquainted with the sequence of conditions which led up to the storm, or to that other sequence which led up to the sailing, we should never discover the wreck among them. That was an accident, the coming together of two independent lines of causation which until that coinciding moment had no reference to one another."¹

That which, judged by known mechanical laws, is an accident, may turn out upon further knowledge to be determined by a law. In that case we should have to say that we were mistaken in supposing that we had to do with independent systems. But

¹ G. H. Palmer, *The Problem of Freedom*, pp. 138-139. It may be argued that the total cosmos at each moment is a function of similar cross-sections at previous moments. But this sweeping generalization, though true, is irrelevant. The special threads of causal connection which science traces cannot be deduced from this generalization, nor is their absence in particular cases contradicted by it. The fact is that there is no single cosmic law, but a considerable variety of laws that are quite independent of one another. In order to deduce a total cosmic phase from an earlier phase, it would be necessary to employ a great many different laws and to make a great many independent deductions. Cf. *ibid.*, p. 148.

that would not alter the case as respects purpose. It would only show that a notable or novel situation was a determined phase of a temporal system as discussed above. To discover that what was thought to be a remarkable coincidence was after all determined would not argue that it was intended. If with all our knowledge of mechanical laws the coincidence remains a coincidence, this leaves open the possibility that it has a purposive explanation. In other words, that which is mechanically accidental may afford an instance of something whose only explanation is purposive. But its being mechanically accidental does not in itself prove that it has a purposive explanation. Its mechanical contingency may be the last word in the matter. And this holds quite independently of the extent to which the coincidence is 'remarkable.' If there are to be coincidences at all, some will be remarkable and some not, and that those within our notice should have been of the former variety is, as we have seen in the former article,¹ entirely in keeping with the theory of chances. In other words, if a new kind of determination, such as purpose, is to be invoked, it must be because of some further datum connected with the origin of the occurrence which we call a coincidence.

It is characteristic of all temporal events that they precede some future event, which they determine according to law, or for which they supply some partial condition. They can be more or less completely described with reference to this sequel, as leading, conducing, or tending to it. But something more is required in order to make it significant to say that the event occurs for the sake of the sequel. The *sequel as prospective* must somehow play the decisive rôle in the determination of the event. Or it must appear that the event is a function of the prospective sequel, and varies with it. We need more than causal sequence or tendency. It is implied in such expressions as 'in order to,' and 'for the sake of,' not only that an event has a prospective sequel, but that its having that prospective sequel rather than some other, accounts for the event's taking place. The second law of thermodynamics would be purposive in this sense only provided it meant that each change of energy was at least to

¹ *The Monist*, Vol. XXVII, July, 1917, pp. 371-374.

some extent due to its being a step in the direction of its general dissipation and impotence.

If temporal direction or tendency does not signify purpose in the case of inorganic phenomena, neither of them is more significant in the case of organic phenomena. In other words, if the differentia of life is purpose, then the differentia of life cannot be merely the temporal direction of tendency. That life exhibits tendencies cannot be doubted. Growth, for example, may be regarded as a tendency to progressive increase, or to such crucial phases as maturity and death. But if this be all there is to growth, then there is no more occasion to invoke purpose than in the case of a body's tendency to progressive increase of velocity, or a liquid's tendency to freeze, or energy's tendency to stagnation. Trains and steamships may tend to reach their destinations on schedule time; individual conduct may tend to a state of happiness, power or possession, that we call the agent's aim or goal; nations may tend to progressive expansion or to a place in the sun; human society in general may tend to a progressively greater complexity and organization, or to a perfect equilibrium of mutually adjusted interests. But if there is any purpose in such changes, or anything to distinguish them from the common characteristics of inorganic changes, it must consist of something over and above that mere aspect of tendency which has already been described. It will not suffice to point out that these changes proceed *toward* a state which is novel or discontinuous or remarkable; it will not suffice to point out that many causes and conditions so combine, whether by law or by chance, as to give rise to a phase that has a marked individuality of its own.

3. It has been supposed that although tendency may not in itself be a sufficient criterion of purpose, such a criterion may be found in the relation of an external agency to a tendency. Given a tendency, it is argued that an external agency may either ally itself therewith, or retard it; and that when this is the case, such an agency may be said to be 'for' or 'against' it. This duality of relationship is offered as a definition of utility or disutility.¹

¹ Cf. W. H. Sheldon, "An Empirical Definition of Value," *Jour. of Phil., Psych., and Scientific Meth.*, Vol. XI (1914), p. 113.

But it seems perfectly clear that the relationships in question are just as characteristic of the inorganic world as of the organic, and that they introduce nothing new in principle. The acceleration of a moving body may be reinforced by impact from without; or a river's flow toward the sea may be 'favored' by the contour of the earth's surface. In such cases we have accidental concurrence of the type already discussed. Where, on the other hand, the facilitating agency 'conspires' with the tendency, then it is incorrect to regard it as external. It is simply one of the factors of the tendency itself, and its favoring the tendency means nothing more than its sharing in its determination. In this sense it would be just as reasonable to speak of the mass of the earth as favoring the fall of a body towards its center. Any partial cause combines with other causes to produce an effect, and may be thought of as auxiliary to these other causes. In so far as we are interested in the effect, we are likely to speak of such an auxiliary cause as 'favorable' to the effect, suggesting that the cause is itself interested in the outcome. But this is the pathetic fallacy again. There is nothing of purpose in an auxiliary cause that is not present in any cause. It follows that in so far as life is merely so conceived, it affords no differentia of purpose. The organism tends to increase, to acquire a certain form, to reach this or that stage in which new properties appear. Environmental circumstances and events will sometimes supply necessary conditions for this process, and reinforce it; or will at other times retard and obstruct it. But there is no more reason to suppose that anything is done 'on purpose' in this case than in the cases of inorganic causal concurrence.

4. Let us now consider a new type of process which is especially characteristic of life, and for which we may, I think, legitimately employ the biological term 'adaptation.' But I shall ordinarily employ the expression 'complementary adjustment' to emphasize its distinctive character, as an interchange of action and reaction having a constant sum or result. The simpler variety of this type is what we may call 'compensatory adjustment.' A first system, the organism, acts upon a second system or group of systems, called the environment, so as to recover and maintain

a constant state. We suppose a certain initial or normal state of the first system; and find that when, owing to either internal or external causes, this state is altered, certain compensatory changes arise within the system itself which restore the normal state.

This conception plays an important rôle in the 'biomechanical' philosophy of Avenarius, and the theory of value which his followers have developed. The *biomechanische Grundgesetz* is expressed as $f(R) + f(S) = 0$, where R is the external stimulus, and S the *Nahrungsstoff*, or the energies and substances of which the organism is composed. The formula then signifies that the changes induced in the organism by the action of the environment, are precisely offset by the *Stoffwechsel* or metabolic processes. In this view, centrally initiated changes by which the organic equilibrium is disturbed are also construed as the indirect action of the environment. The law prescribes that compensatory changes shall then be set up within the organism such as to restore the equilibrium.¹

Let us see what this conception implies. In the first place, it is implied that the action of the environment is determined independently of the organism. It has to be thought of as external to the organism; or as imposing from without conditions which the responding organism has got to meet. Whether or not it should turn out to be possible to include the organism and the environment in one larger system, the principle of compensatory adjustment appears only when one thinks in terms of the narrower system of the organism, and regards events in the environment as from that standpoint, at least, accidental. That which an organism adapts itself to must be supposed to vary independently. In the second place, it is implied that the organism contains a reserve of energy, which the action of the environment releases. The action or response of the organism consists of the more or less 'spontaneous' changes conditioned mainly by the potentialities of the organism itself; and these will bear no constant quantitative relation to the amount of the

¹ Cf. F. Carstanjen, *Richard Avenarius' Biomechanische Grundlegung der neuen allgemeinen Erkenntnistheorie*, p. 24; R. Eisler, *Studien der Werttheorie*, p. 21.

stimulus. Finally, it is implied that this response of the organism is constant in a certain peculiar respect. It is always such that when its effects are added to those of the stimulus the resultant effect is a return to the first state of the organism. The effect of the response is to cancel the effect of the environment. If we symbolize the initial state of the organism by O_1 , the action of the environment by E_a , and the response by O_r , we may then express the total operation by the formula, $O_1 + E_a - O_r = O_1$. None of these factors can be omitted without altering the essential character of the operation.

We may speak of this operation as a tendency to *maintain* equilibrium. This is a very different thing from the tendency to equilibrium, simply. The tendency to maintain, qualifies the responses of the organism, and would mean nothing unless there were external changes impairing the O_1 , and calling forth appropriate counter-acts on the part of the organism. A tendency to equilibrium, simply, would mean nothing more than a change whose earlier phases were linear, whereas a later phase was punctual or circular. This would be illustrated as we have seen, in a moving body's coming to rest, or in the genesis of a planetary system, or in the dissipation of energy. It would be meaningless in any of these cases to speak of a tendency to maintain equilibrium. Such a tendency would be exhibited only provided, for example, a body at rest possessed a supplementary mechanism, which so operated as to restore the state of rest, whenever that was disturbed by any adventitious agency. The proof of the possession of such a mechanism would lie in its action's being regularly complementary to varying disturbances. Similarly a clock tends to equilibrium in so far as it runs down. It could be said to tend to maintain equilibrium, only provided over and above the tension of its main-spring, there were an auxiliary mechanism which so acted as to restore that tension whenever it was exhausted. A self-winding clock would in this respect resemble an organism.

An organism may be said to tend to keep going. Consider, for example, the following description, borrowed from Hobhouse:

"Mechanically, the organism may be conceived, like any other

mechanism, as essentially an arrangement for the transformation of energy. Thus the animal organism takes up energy in the form of food on the one hand and of oxygen on the other. For each process of absorption it has its appropriate mechanism, the alimentary and the respiratory organs. Next, it has to distribute what it absorbs by means of its circulatory system, and thereby to nourish nerve and muscle tissues wherein the potential energy of the foodstuffs is converted into energy of motion, so directed through the nervous control as to secure fresh supplies of energy and at the same time maintain at the right point, neither too high nor too low, the temperature at which this persistent activity of change or metabolism can go on."¹ To construe this as a case of compensatory adjustment, means that when the organism is below par, when the scales are tipped, when the vitality is depressed, energies are liberated which so combine with the environment as to bring the organism back to par.

Let us take another description which emphasizes the central rather than the peripheral source of the disturbance. ". . . In all animals we find that when the supply of food is decreased below the normal the activity of the search for food increases correspondingly; there is increased reactivity to food materials; this is the physiological correlate of 'hunger'; the chances of securing what is needed to maintain the equilibrium are thus increased."² In this case, a certain degree of exhaustion on the part of the organism sets up those complementary acts which are to revive the organism. But the process of nutrition is by no means the only physiological process which exhibits this principle. It is equally well illustrated by the simple reflexes, such as the coughing reflex, by which a foreign particle is removed from the mucous membrane of the larynx, or the acceleration of breathing when an excessive amount of carbon dioxide is given off by the muscles, by the healing and regenerative process, by the formation of callus on the skin, or by the activity of the anti-bodies in resisting the invading microorganisms of disease.

¹ L. T. Hobhouse, *Development and Purpose*, p. 303.

² R. S. Lillie, "What is Purposive and Intelligent Behavior from the Physiological Point of View?" *Jour. of Phil., Psych., and Scientific Methods*, Vol. XII (1915), p. 592.

In all these cases there is a mechanism of recovery which is released whenever the system rises above or falls below a certain zero point, and the effects of which are equal in quantity and opposite in sign to those of the disturbing agency.

5. But the principle is apparently equally well illustrated by the operation of certain inorganic mechanisms. Some instances which have frequently been cited in this connection evidently will not serve. The candle-flame exhibits a certain constancy of form despite the change of its materials; and if its form is altered, say by a gust of wind, it will return again to the same form. But this means only that when the disturbing cause is removed, the original causes will operate as before. It means only that the effect of the disturbing cause is temporary; the system itself does nothing to counteract it. The same analysis holds in the case of the whirlpool or cataract. There is here nothing more than is to be found in the simplest mechanical phenomena. Suppose a body to be obeying the law of inertia and to be moving with a uniform velocity. A second body may be introduced and the motion will be accelerated. Then when the second body is withdrawn, the law of inertia resumes its sway, and the first body returns to a condition of uniform velocity. Meanwhile the first body has done nothing to offset the disturbance, or to maintain its first state against the intruding force.

But a genuine case of complementary adjustment is apparently afforded by the governor of a steam-engine, and by the thermostat. A house equipped with a furnace and a thermostat does tend to maintain a constant temperature. When the temperature rises or falls above the point at which the thermostat is set, whether owing to changes in the environment or to changes within, a mechanism of recovery is released, and is so determined in its operation as to neutralize the disturbing agency. Provided the heating-plant is able to cope with fluctuations of temperature which are usual in its environment, the building so equipped may be said in respect of temperature to be 'adapted' to that environment. The fact that automatic heating-plants have been designed by human minds, and created by human hands, is accidental so far as these automatisms themselves are concerned.

There is no reason to suppose that they might not have originated in the course of nature. The *modus operandi* of invention or handicraft is doubtless another matter; but we must not confuse it with that of the mechanism itself.

6. Let us now consider what appears to be a different type of complementary adjustment, to which we shall give the name 'progressive adjustment.' A growing organism evidently does not merely tend to maintain itself; it increases to or toward a certain maximum, which thereafter it tends to maintain. It is as though the equilibrium were unbalanced at the outset. The growing organism tends to arrive at an equilibrium which it has never as yet possessed. Such an operation can be represented as follows: $O_1 + E_1 + R_1 = O_2$; $O_2 + E_2 + R_2 = O_3$; $O_3 + E_3 + R_3 = O_4$, etc., where R_1, R_2, R_3 , represent the successive responses, and $O_1, O_2, O_3 \dots O_n$ successive states of the organism approaching O_n . When the organism reaches the state O_n , the operation comes to an end, or takes the form of compensatory adjustment described above. The successive responses of the organism are complementary to an independently varying environment, but the algebraic sum of environment and response, instead of being zero, is some intermediate term of an orderly series which has a last term. This last term, in the case of the growing organism the state of maturity, may be said to be what the organism is tending to do or accomplish. It is not merely a tendency to become something, exhibited by an isolated system, but a tendency so to deal with external and contingent events as to promote the tendency. This implies an independent variability on the part of circumstance or environment, and a complementary variability on the part of the organism. The responses of the organism are not simple functions either of the existing state of the organism, or of the confronting environment; but they are such as when combined with the confronting environment produce a state of the organism which belongs next to its existing state in an orderly progression. We can represent this more abstractly by letting Roman numerals symbolize the action of the environment, and Arabic numerals the action of the organism. Compensatory adjustment can then be repre-

sented by $I - 1 = 0$, $II - 2 = 0$, $III - 3 = 0$, etc.; whereas progressive adjustment would then be represented by $I + 1 = 2$, $III + 0 = 3$, $V - 1 = 4$, $II + 3 = 5$, until the algebraic sum reaches 10, at which point this particular deed is done, and the process assumes the form $I - 1 = 0$, etc.

But growth is far from being the only instance of the process which life affords. Such a process is illustrated by all reflexes that are not of simple protective type. Consider, for example, the instance of hunger above cited. The decrease of the food supply below par excites the organism to compensatory adjustment. But in its dealings with the environment the hungry organism exhibits adjustment of the progressive type. It does not act so as to neutralize the environment, but so as to combine with it in producing an orderly increase of satisfaction. In other words, equilibrium is restored progressively.

Needless to say it is quite possible that when a first progressive adjustment is completed it may be succeeded not by a compensatory process, but by a second progressive adjustment, or by a series of progressive adjustments. In so far as instinctive action, such as the begetting and rearing of offspring, can be reduced to a series of reflexes, it is evidently of this type.

7. But what is ordinarily regarded as instinctive action involves a new principle, which we shall now introduce under the name of 'preparatory adjustment.' Consider the following account of instinct offered by R. S. Lillie:

"Many animals in temperate zones make in autumn or throughout the year special provision for passing the winter. Frogs hibernate, many birds fly south, squirrels collect stores of food, various insects such as bees do the same, others construct cocoons, cysts, or burrows in which they or their larvae lie dormant during the cold period. . . . How are these various reactions to be regarded from the physiological standpoint? It is first to be noted that all show one evident characteristic. They may be regarded as *protective* reactions having reference to a certain definite and regularly recurring situation in the external world, namely, the coming of a prolonged period in which temperature is low and food is scarce. Now what is to be especially

noted is that in every one of the above cases the characteristic behavior, which has reference to the *whole* situation, is called forth or initiated by only a *part* of the same, and often a quite inconspicuous part."¹

Although, as our author says, this performance is one of maintaining equilibrium, as a matter of fact the equilibrium is not disturbed. Its disturbance is not offset or neutralized, but is *averted*. That which is reacted to is not a disturbance of equilibrium, but the prospect or threat of such disturbance. A series of environmental changes is inaugurated which if allowed to take their course would disturb the organism's equilibrium; but the organism takes time by the forelock, meets these changes half-way, and does not allow them to take their course.

If we wish in this case to view the responses of the organism as complementary to the action of the environment, we must correlate a series of the former with a series of the latter. A cycle of organic responses is complementary to a cycle of environmental changes. Or, in order that a certain environmental change may be met so as to maintain the organism's equilibrium, it is necessary that the organism's response should be begun at a certain time in advance. The adjustment to it takes time, and must be started before the environmental change has been completed. The early stages of the response will in that case fail to exhibit the compensatory relation to those changes of the environment which call them forth. This type of response can be represented as follows: Let R_1 represent the initial response of an organism to E_1 which marks the beginning at t' of a cycle of changes in the environment. E_1 , for example, is the autumnal temperature, and R_1 the first movement of a migratory bird toward the south. E_2 , E_3 , etc., would then represent the further seasonal changes, and R_2 , R_3 , etc., the bird's continued southerly flight. Then, although R_1 does not exhibit the complementary relation to E_1 , nor R_2 to E_2 , etc., the cycle of responses $R_1 \cdots R_n$ is complementary to the cycle of environmental changes $E_1 \cdots E_n$; that is, the removal to a warmer climate is complementary to the coming of winter, in that it prevents a

¹ *Op. cit.*, pp. 603-604.

disturbance of equilibrium which would otherwise have taken place. We can say that $(E_1 \cdots E_n) - (R_1 \cdots R_n) = 0$; but must bear in mind that since the two cycles develop simultaneously the disequilibrium $O_1 + E_n$, for example, never occurs. When at t^n the environmental change is completed which would have disturbed the balance had the organism remained as at t' , or had its responses been tardy, these responses have reached a point which nullifies the environmental change.

But it is not necessary to look for examples among serial responses of so complicated a nature. The animal which endeavors to escape its enemy illustrates the same principle of preparatory adjustment. The commencement of the flight is not complementary to the appearance of the enemy at a distance, but the flight as a whole is complementary to the pursuit as a whole. In some measure this principle is obeyed by all protective reflexes that are stimulated by telesthesia or distance sensation, such as vision, hearing and smell.

Again, this principle obtains not only in the case of compensatory adjustment, but in the case of progressive adjustment as well. The animal which pursues its prey engages in a series of responses which exhibit their progressively complementary character only when they terminate in the capture of the prey. The pursuit as a whole, taken as a response to the flight as a whole, produces a result which constitutes a phase in the progressive satisfaction of hunger. Similarly, the complex series of responses involved in the perpetuation of the species, is progressive and not compensatory merely; but only in so far as these responses are subdivided into unit-cycles, such as procreation, nest-building, food-getting, etc., where the earlier phases of each unit-cycle are complementary only in respect of what they prepare or make ready.

8. Shall we, then, regard behavior of this complementary sort as purposive? Shall we say that the organism *seeks* to avoid death or loss of vitality? Shall we say that the organism procures food *for the sake* of completing its growth? Shall we say that the organism stores food or builds nests, *in order to* perpetuate the species?

That complementary adjustment is important and distinctive in principle is not to be denied. Nor is there any absolute ground for rejecting the terminology of purpose. The important thing is to distinguish principles, and not to label them. It certainly would not be nonsense to speak of the interior temperature for which the thermostat is set as good, since the heating-plant tends to maintain it; and to speak of a cold wind or open window as bad, since it needs to be offset by a restorative mechanism. Similarly it would not be nonsense to speak of the maturity of a plant as good, since the organism's responses tend to bring the organism to that form; and to speak of food as good since the organism's responses utilize them. The propriety of such a use of terms will depend on whether or not there is a more restricted use which is more convenient. That there is such a more restricted use is evident. These terms can be reserved for *plastic* or *modifiable* adjustment, as distinguished from adjustment of the automatic type so far described. Let us turn now to a more careful examination of the meaning of automatism.

The complementary adjustment of the types so far considered can be summarily expressed by the formula, $E + R = C$. The responses of the adapted system vary with the action of the environment according to some constant rule. The sum of the stimulus and the response may be zero, as in the case of simple compensatory adjustment; or the sum may be some value of an orderly series, as in the case of progressive adjustment; or, as in the case of preparatory adjustment, a series of responses may so combine with a series of stimuli as to give rise to a sum, which is either zero, or some value of an orderly series. In all of these cases, whether simple or complex, the independent variable is the environmental action, the dependent variable is the organic response, while the outcome or resultant is constant. Hence we may say that the organism *behaves in a variety of situations in such wise as to produce a constant result*. The organism may be said to be adapted to the environment in respect of that constant result. But it is not significant to say that the response occurs *because of* that result. Given the constant result as a law, the response occurs because of the stimulus. In order to make it

proper to speak of the response as occurring because of the result, it would be necessary that the result itself should be the independent variable. We must be able to say: when $E + R$ results in a certain way, M , then $E + R$ occurs; otherwise not. Behavior is automatic when, given a value for the stimulus, the response may be deduced from some constant or rule.

The occurrence of such responding mechanisms, and their recurrence or persistence, might be due to accident, or might be due to natural selection. In an environment possessing a certain constancy, where a class or sequence of stimuli is recurrent, the responsive mechanisms that will tend to survive will be those whose responses are complementary to the environment in respect of survival. Professor Lillie has shown that the elaborate preparatory responses characteristic of animal instinct are of the same type as the simpler reflexes which are ordinarily supposed to exemplify automatism.

"On closer examination such an instinctive action, though complex, is seen to have all the characteristics of a simple protective or food-securing reflex, as regards both the conditions under which it is aroused and its ultimate effect on the life of the animal itself or of its species. In every case of a purposive instinct we find the organism reacting *in a constant manner* to a condition *that recurs with constancy*. The case differs from the direct reaction to the presence of food-material only in its complexity, and in the fact that the total situation to which adjustment is made *takes time to develop*, and, hence, an essential part of the reaction involving adjustment is made in advance."¹

The cycle of the seasons is a constant feature of any given environment. An organism adapted to any given environment will possess not only specific responsive propensities, but a more complex propensity to a temporal series of responses which form a cycle complementary to that of the seasons. If natural selection can account for the more simple case it can equally well account for the more complex case. The latter is equally automatic in the sense that the complementary character of the interaction,—its organized or systematic character, is simply a description or

¹ *Op. cit.*, pp. 604-605.

law which holds of the action of the component agents. The responding organism behaves in a constant manner which can be formulated as $E + O = C$; its behavior illustrates or exhibits this law. But it cannot be said of the organism that it so behaves as to *bring this law into operation*. The law is the determination of its behavior, but not the effect of its operation. For conduct determined by the fact that it brings complementary adjustment into existence, we must look further.¹

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¹ Cf. an article entitled "Docility and Purposiveness," to be published in *The Psychological Review* for January, 1918.